

WHAT IS CLAIMED IS:

1                   1.     A double-gimbaled micromachined mirror structure for parallel-plate  
2     electrostatic operation, said mirror structure comprising:  
3                   a frame;  
4                   a mirror;  
5                   a gimbal around said mirror;  
6                   a plurality of hinge structures at four positions on said gimbal, a first pair of  
7     said hinge structures connecting said mirror to said gimbal and a second pair of said hinge  
8     structures connecting said frame to said gimbal, said hinge structures permitting motion  
9     substantially only normal to said mirror and wherein adjacent each element of said second  
10    pair is a tab extension from said mirror for serving as rotational displacement limitation; and  
11                  overhanging structure adjacent each of said four positions and disposed to  
12    confront each said tab extension to limit rotational displacement of said mirror.

1                   2.     The apparatus according to claim 1 wherein said overhanging structure  
2     and said mirror are maintained in sufficient differential in potential to permit detection of  
3     contact of said overhanging structure and said mirror through detection of voltage change.

1                   3.     The apparatus according to claim 1 wherein said overhanging structure  
2     and said mirror are maintained in sufficient differential in potential to permit detection of  
3     contact of said overhanging structure and said mirror through detection of current change.

1                   4.     The apparatus according to claim 1 wherein said overhanging structure  
2     and said mirror are maintained in equipotential.

1                   5.     The apparatus according to claim 1 wherein said detectable differential  
2     is sufficiently small to inhibit arcing upon contact between said overhanging structure and  
3     said mirror or gimbal.

1                   6.     The apparatus according to claim 1 wherein each of said first pair of  
2     hinge structures includes a gimbal wraparound for serving as rotational displacement  
3     limitation in confrontation with said overhanging structure.

1                   7.     The apparatus according to claim 1 wherein said overhanging structure  
2     is disposed to provide a clear aperture at all design viewing angles of said mirror.

1                    8.        The apparatus according to claim 1 wherein said detectable differential  
2 is sufficiently small to inhibit arcing upon contact between said overhanging structure and  
3 said mirror or gimbal.

1                    9.        A double-gimbaled micromachined mirror structure for parallel-plate  
2 electrostatic operation, said mirror structure comprising:

3                    a frame;

4                    a mirror;

5                    a gimbal around said mirror;

6                    a plurality of hinge structures at four positions on said gimbal, a first pair of  
7 said hinge structures connecting said mirror to said gimbal and a second pair of said hinge  
8 structures connecting said frame to said gimbal, said hinge structures permitting motion  
9 substantially only normal to said mirror and wherein adjacent each element of said first pair  
10 is a gimbal wraparound for serving as rotational displacement limitation; and

11                    overhanging structure adjacent each of said four positions and disposed to  
12 confront each said gimbal wraparound to limit rotational displacement of said mirror.

1                    10.       The apparatus according to claim 9 wherein said overhanging structure  
2 and said mirror are maintained in sufficient differential in potential to permit detection of  
3 contact of said substrate and said mirror through detection of voltage change.

1                    11.       The apparatus according to claim 9 wherein said overhanging structure  
2 and said mirror are maintained in sufficient differential in potential to permit detection of  
3 contact of said substrate and said mirror through detection of current change.

1                    12.       The apparatus according to claim 9 wherein said overhanging structure  
2 and said mirror are maintained in equipotential.

1                    13.       The apparatus according to claim 9 wherein said detectable differential  
2 is sufficiently small to inhibit arcing upon contact between said mirror and said overhang.

1                    14.       The apparatus according to claim 9 wherein near each element of said  
2 second pair is a tab extension from said overhanging structure for serving as rotational  
3 displacement limitation on said mirror.

1                   15.     The apparatus according to claim 1 wherein said overhanging structure  
2 is disposed to provide a clear aperture at all design viewing angles of said mirror.

1                   16.     The apparatus according to claim 9 wherein said overhanging structure  
2 is disposed to provide a clear aperture at all design viewing angles of said mirror.

1                   17.     The apparatus according to claim 1 wherein said overhanging structure  
2 is disposed over said mirror and mounted on a flipped SOI handle structure.

1                   18.     The apparatus according to claim 9 wherein said overhanging structure  
2 is disposed over said mirror and mounted on a flipped SOI handle structure.

1                   19.     The apparatus according to claim 1 wherein said overhanging structure  
2 is disposed over said mirror and formed in a bevel etched by potassium hydroxide.

1                   20.     The apparatus according to claim 9 wherein said overhanging structure  
2 is disposed over said mirror and formed in a bevel etched by potassium hydroxide.

1                   21.     The apparatus according to claim 1 wherein said overhanging structure  
2 is disposed over said mirror and formed of a thinned silicon wafer.

1                   22.     The apparatus according to claim 9 wherein said overhanging structure  
2 is disposed over said mirror and formed of a thinned silicon wafer.

1                   23.     The apparatus according to claim 1 wherein said hinge structures are  
2 folded longitudinal gimbal hinge structures.

1                   24.     The apparatus according to claim 9 wherein said hinge structures are  
2 folded longitudinal gimbal hinge structures.

1                   25.     The apparatus according to claim 1 wherein said folded longitudinal  
2 gimbal hinge structures attached to the gimbal are recessed into the mirror.

1                   26.     The apparatus according to claim 1 wherein said mirror is round.